	Heat Vs Temperature	Heat Insulation	Heat Box	Heat Engine Cups
Student Experience	Students make predictions about the temperature of various materials. Students place their hands in these materials and record their observations. The class discusses concepts and misconceptions of heat and temperature. Afterwards student conduct lab data to better understand the 1st Law of Thermodynamics.	Students measure the heat conduction rate of various materials to determine insulation properties. Students read an article on heat insulation and use a CCSS strategy of reading for a purpose. Students learn how to calculate heat transfer coefficient. Using data from experiment, research from article, and mathematical calculations, students redesign their heat insulation container.	Students use their data from the heat insulation activity to design a box that demonstrates three methods of heat transmission	Students experience and make modification to a simple heat engine model.
T4T Material	Per lab group, 4 containers that have small materials with differing heat conduction rates (in addition, each group will need a thermometer)	Containers with lids to hold between 100-200 mL of water, larger container with lids that can hold smaller container and insulating materials; variety of T4T materials that can be used as insulation (thermometers, hot plates, and graduated cylinders)	Containers, other materials from cart that can be used as insulators	String, Cups, candle
Big Idea	Temperature is a measurement of thermal energy. Heat is the transfer of that energy.	Heat conduction rate can be measured using surface area, change in temperature	3 types of heat flow	How steam engines work. Modification of scientific model to discover content
Connection to Culminating Activity	Students develop a clearer understanding of heat and thermodynamics in order to be able to measure and collect data for Put Put boats	Students connect definitions of heat to how heat transfer can be measured building on their understanding of the laws of thermodynamics	Students develop understanding of types of heat flow to	Understanding the basics of a heat engine and how they work. Foundation of their steam engine for their

CA Standards	Physics Heat & Thermodynamics 3a and c	Physics Heat & Thermodynamics 3a	Physics Heat & Thermodynamics 3a	putt putt boats. Physics Heat & Thermodynamics 3b
Next Generation Science Standards				HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
Time	(1-2) 55 minute class	(1) 55 minute class	(2) 55 minute class	(2) 55 minute class

Culminating Activity – Putt Putt Boat				
	Putt Putt Boat Build	**Fan on a Boat**	**Experimenting and Collection Data**	**Putt Putt Boat Reflection**
Student Experience	Students observe a Putt Putt boat prototype. They determine a variable to test and redesign the boat to meet their new criteria. They create a steam engine following provided design specifications. They test sections of their engine as they build to determine construction flaws.	Before adding the engine to their boat, students construct and place a temporary sail. They use a small hand fan and explain and predict whether they should point their fan into or away from the sail. Class discusses third law of motion and how it applies to their sail boat and put put boat. (alternatively, this can be done as a demo prior to building put put boats)	Students design and carry out a test to determine the work of their boat	Students discuss their data and explain concepts of work, Laws of thermodynamics, third law of motion, and heat engines in a written analysis that includes drawings, data, explanations, and improvements Students find evidence to support their argument comparing two Putt Putt models
T4T Material	Aluminum cans, straws, scissors, razors or box cutter, tape, milk cartons and other items from cart, blue tack or epoxy, glue guns	Materials to build mast and sail from cart (also needed: a hand fan, dish pan or similar container to float boats)	N/A	N/A
Big Idea	What is a steam engine: how it converts thermal energy into mechanical energy (work)	Understanding Newton's 3rd Law of Motion and how it explains why the put put boat moves forward	Designing a controlled experiment. Thinking about how they will collect data to measure work.	Apply knowledge of thermodynamics to explain boat and interpret data, use model to create explanations and determine improvements
CA Standards	Physics Heat & Thermodynamics 3b	Physics Motion and Forces: 1d	Physics Heat & Thermodynamics 3g	Physics Heat & Thermodynamics 3a; 3b; 3g

Next Generation Science Standards	HS-PS3-1, 3-3, Crosscutting concepts: Patterns Science & Engineering practice	HS-PS2-2	HS-PS3-1, 3-3, Crosscutting concepts: Patterns Science & Engineering practice	HS-PS3-1, 3-3, Crosscutting concepts: Patterns Science & Engineering practice
Time	Two 55 min periods	One 55 min period	One 55 min period	One 55 min period

*Teacher can adjust pacing based on student needs.